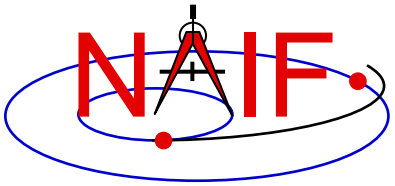

Navigation and Ancillary Information Facility

Using the Frames Subsystem

October 2022

What is the Power of Frames?

Navigation and Ancillary Information Facility

- The "power" of the Frames capability stems from the SPICE system's ability to construct complex reference frame transformations with no programming effort required of you - the end user
  - But it's crucial that you select and load the needed kernels
- The principal benefit from the Frames capability is obtained through the main SPK subsystem interfaces (SPKEZR and SPKPOS) and the Frames subsystem interfaces (SXFORM, PXFORM, PXFRM2)
- The remaining pages illustrate typical use of frames
- Several VERY IMPORTANT usage issues are mentioned in the Frames tutorial; be sure to also read that.

Offset Between Instruments

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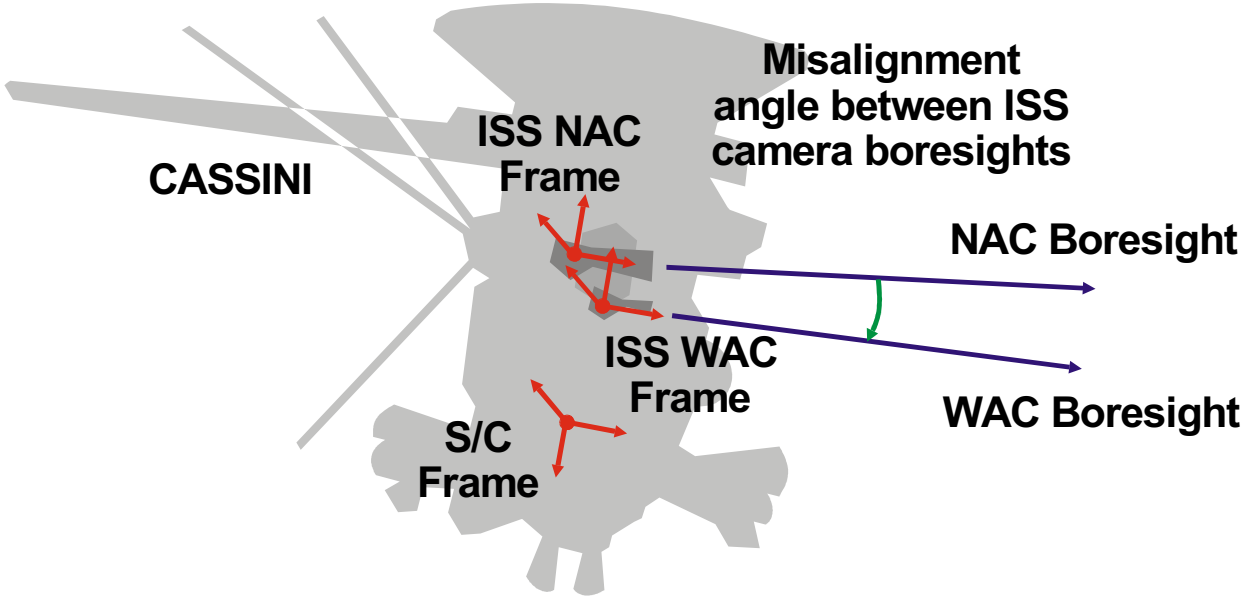

Required Kernels:

- Generic LSK
- Mission FK
- Camera IK(s)

ISS = Imaging Science System

Compute the angular separation between the Cassini ISS Narrow Angle Camera and Wide Angle Camera boresights:

```
C     Retrieve the matrix that transforms vectors from NAC to WAC frame
      CALL PXFORM( 'CASSINI_ISS_NAC', 'CASSINI_ISS_WAC', ET, MAT )
C     Transform NAC boresight to WAC frame and find separation angle
      CALL MXV ( MAT, NAC_BORESIGHT_nac, NAC_BORESIGHT_wac )
      ANGLE = VSEP( NAC_BORESIGHT_wac , WAC_BORESIGHT_wac )
```

Fortran example

Angular Constraints

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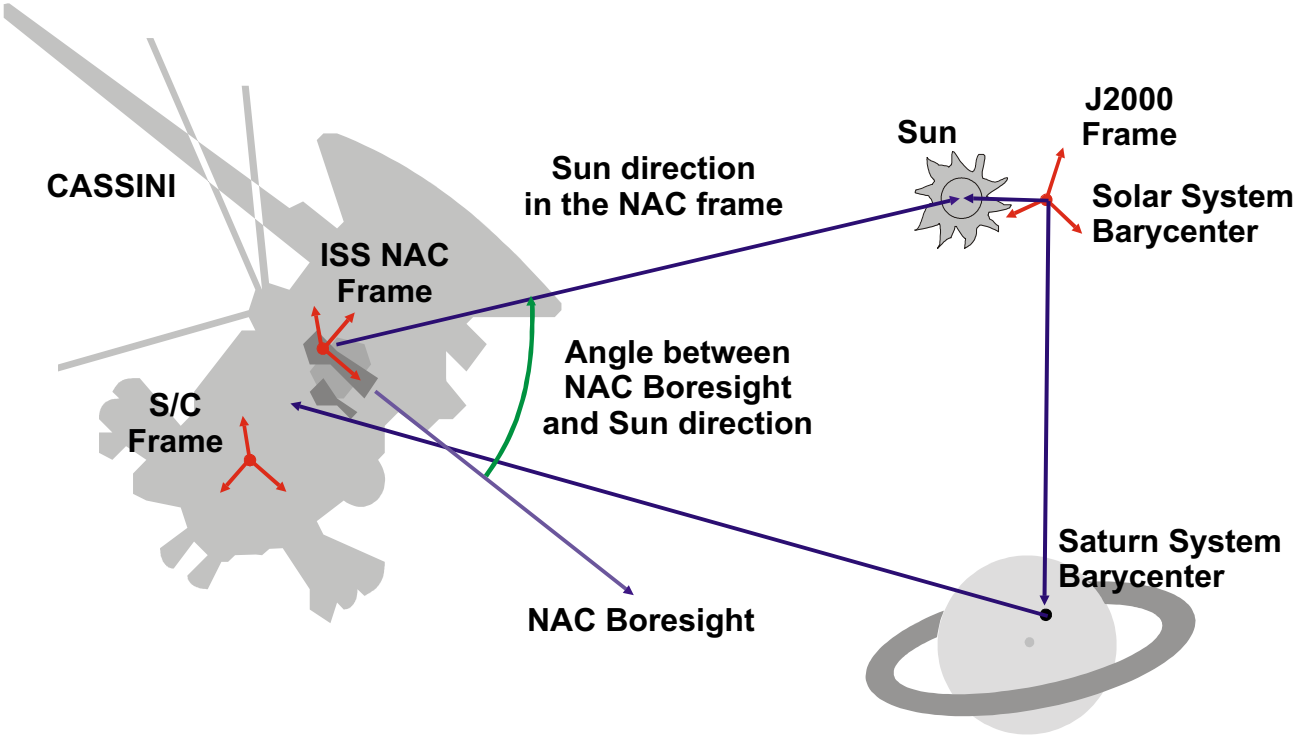

Required Kernels:

- Generic LSK
- Mission FK
- Spacecraft SCLK
- Camera IK
- Planetary Ephemeris SPK
- Spacecraft SPK
- Spacecraft CK

Check whether the angle between the camera boresight and the direction to the Sun is within the allowed range:

```
CALL SPKPOS( 'SUN', ET, 'CASSINI_ISS_NAC', 'LT+S', 'CASSINI', SUNVEC, LT )
ANGLE = VSEP( NAC_BORESIGHT_nac, SUNVEC )
IF ( ANGLE .LE. CONSTRAINT ) WRITE(*,*) 'WE ARE IN TROUBLE!'
```

Fortran example

Angles at the Surface

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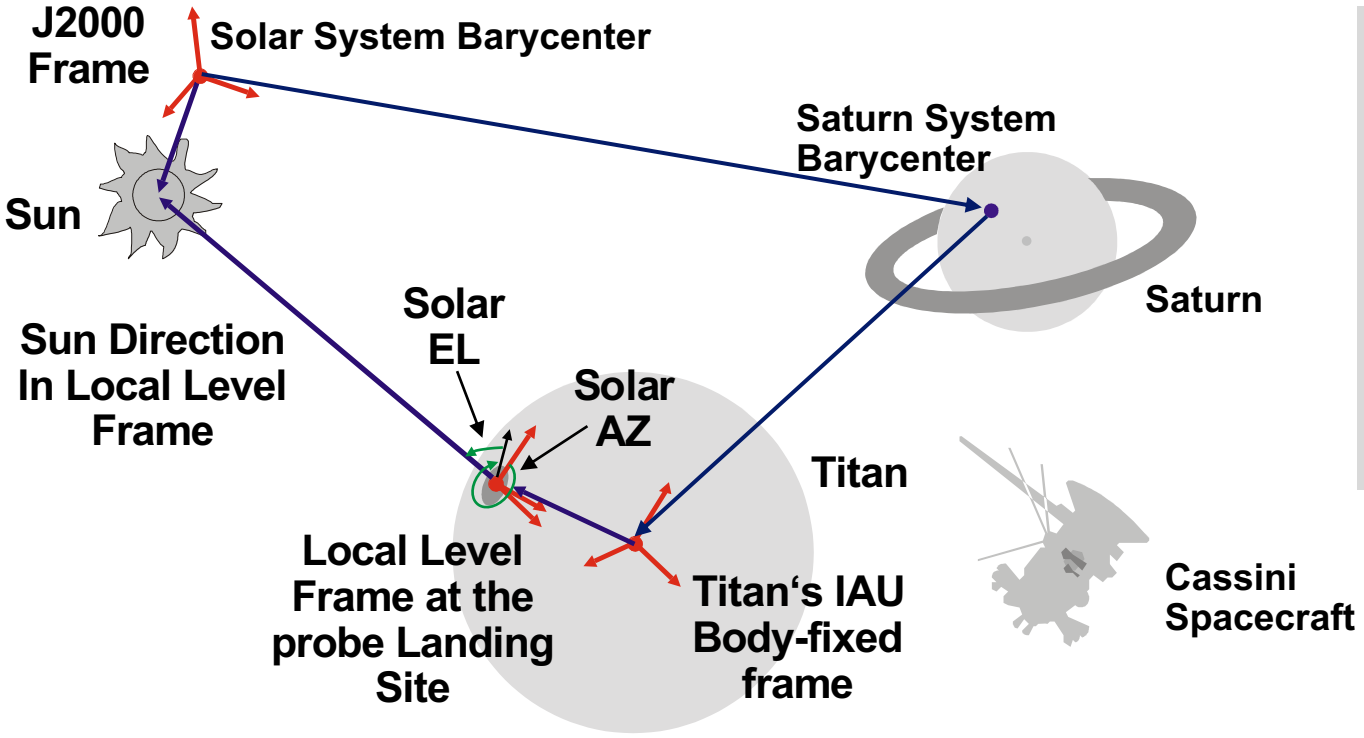

Required Kernels:

- Generic LSK
- Generic PCK
- Mission FK
- Planetary Ephemeris SPK
- Satellite Ephemeris SPK
- Landing Site SPK

Compute solar azimuth and elevation at the Huygens probe landing site

```
CALL SPKPOS('SUN',ET,'HUYGENS_LOCAL_LEVEL','LT+S','HUYGENS_PROBE',SUNVEC,LT)
CALL RECLAT(SUNVEC, R, AZIMUTH, ELEVATION)
ELEVATION = -ELEVATION
IF (AZIMUTH .LT. 0.D0) THEN
   AZIMUTH = AZIMUTH + TWOPI()
ENDIF
```

Fortran example

Relative Position of Sensors

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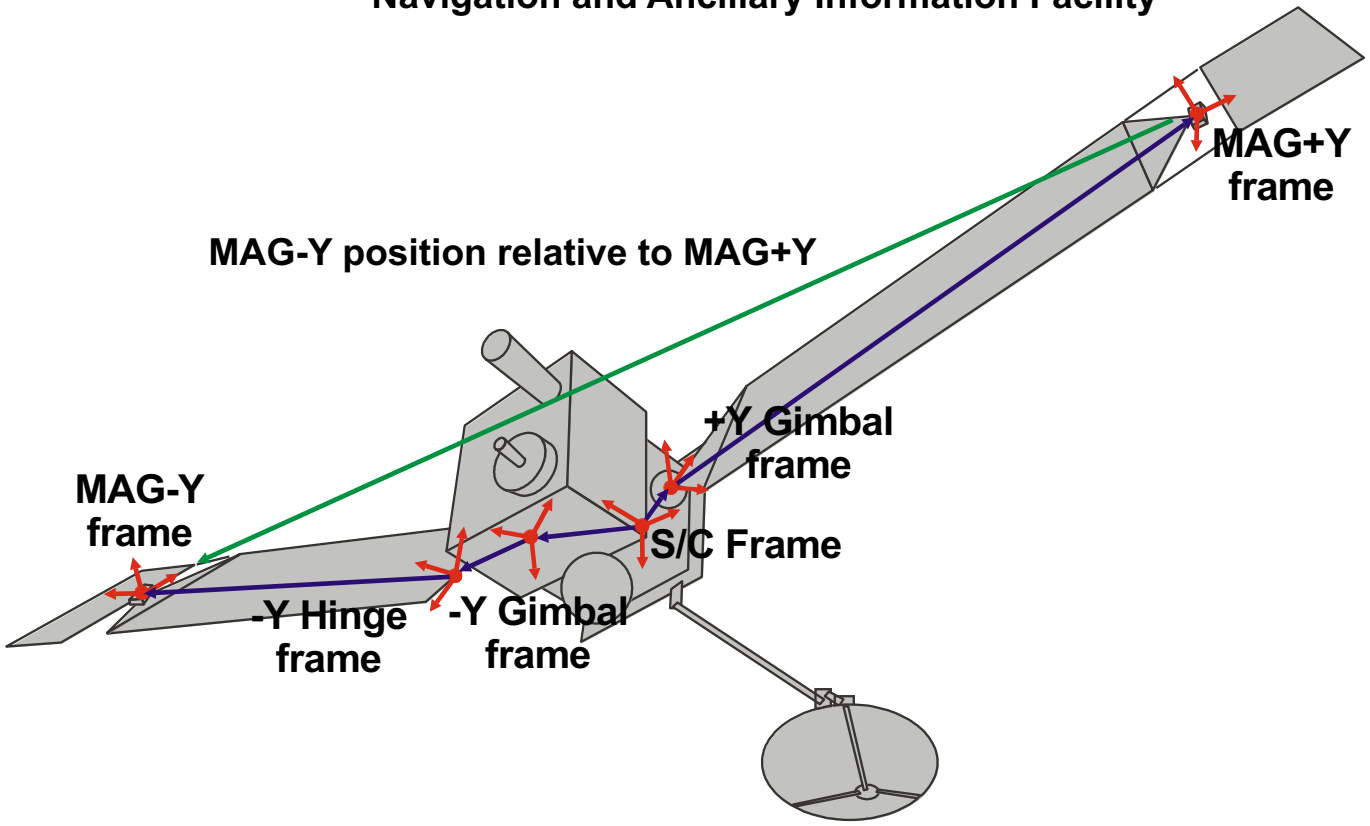

Required Kernels:

- Generic LSK
- Mission FK
- Structure Locations SPK
- Spacecraft SCLK
- Solar Array CK

Find the position of one MGS MAG sensor with respect to the other in the MGS s/c frame. Also find the relative orientation of the sensors:

```
CALL SPKEZR('MGS_MAG-Y', ET, 'MGS_SPACECRAFT', 'NONE', 'MGS_MAG+Y', STATE, LT)
CALL PXFORM('MGS_MAG_+Y_SENSOR', 'MGS_MAG_-Y_SENSOR', ET, MAT)
```

Fortran example

Manipulators - 1

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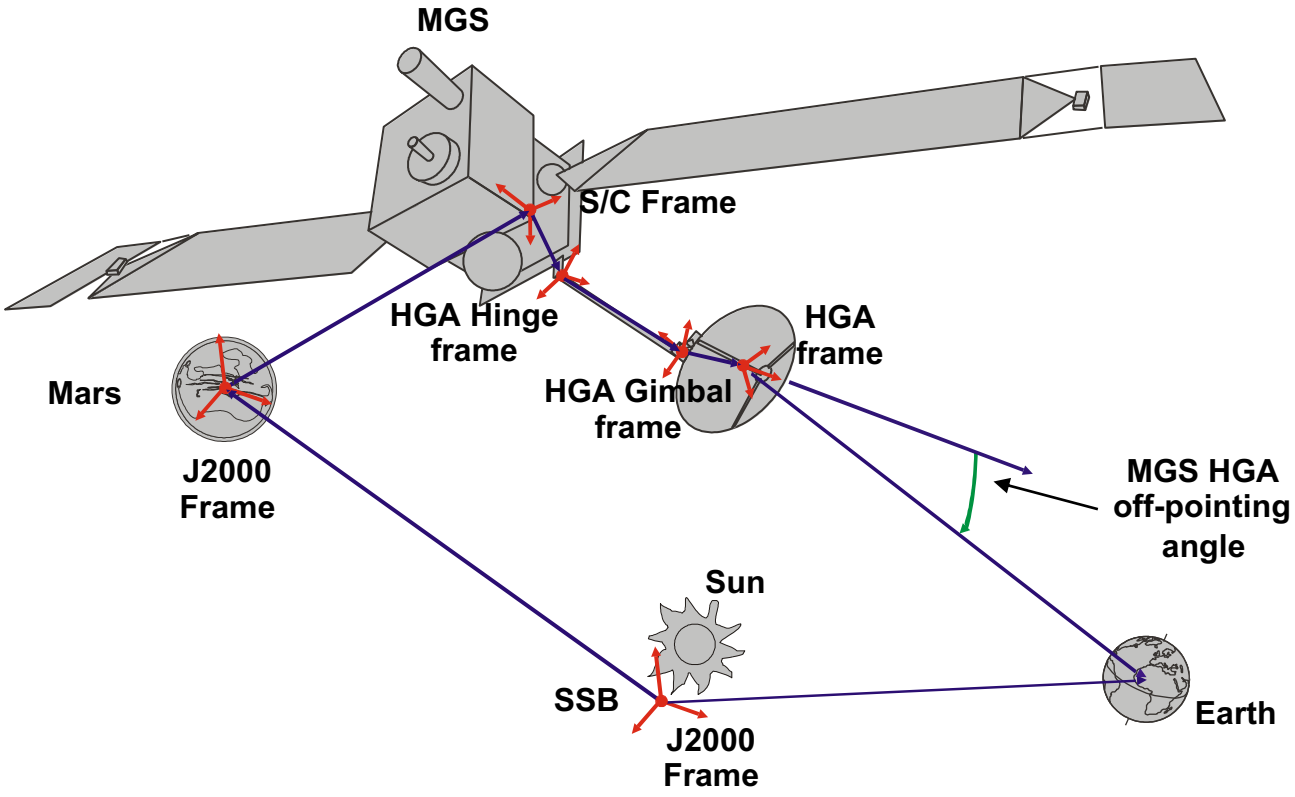


Required Kernels:

- Generic LSK
- Mission FK
- Spacecraft SCLK
- HGA IK
- Structure Locations SPK
- Planetary Ephemeris SPK
- Spacecraft SPK
- Spacecraft CK
- HGA CK

HGA = High Gain Antenna

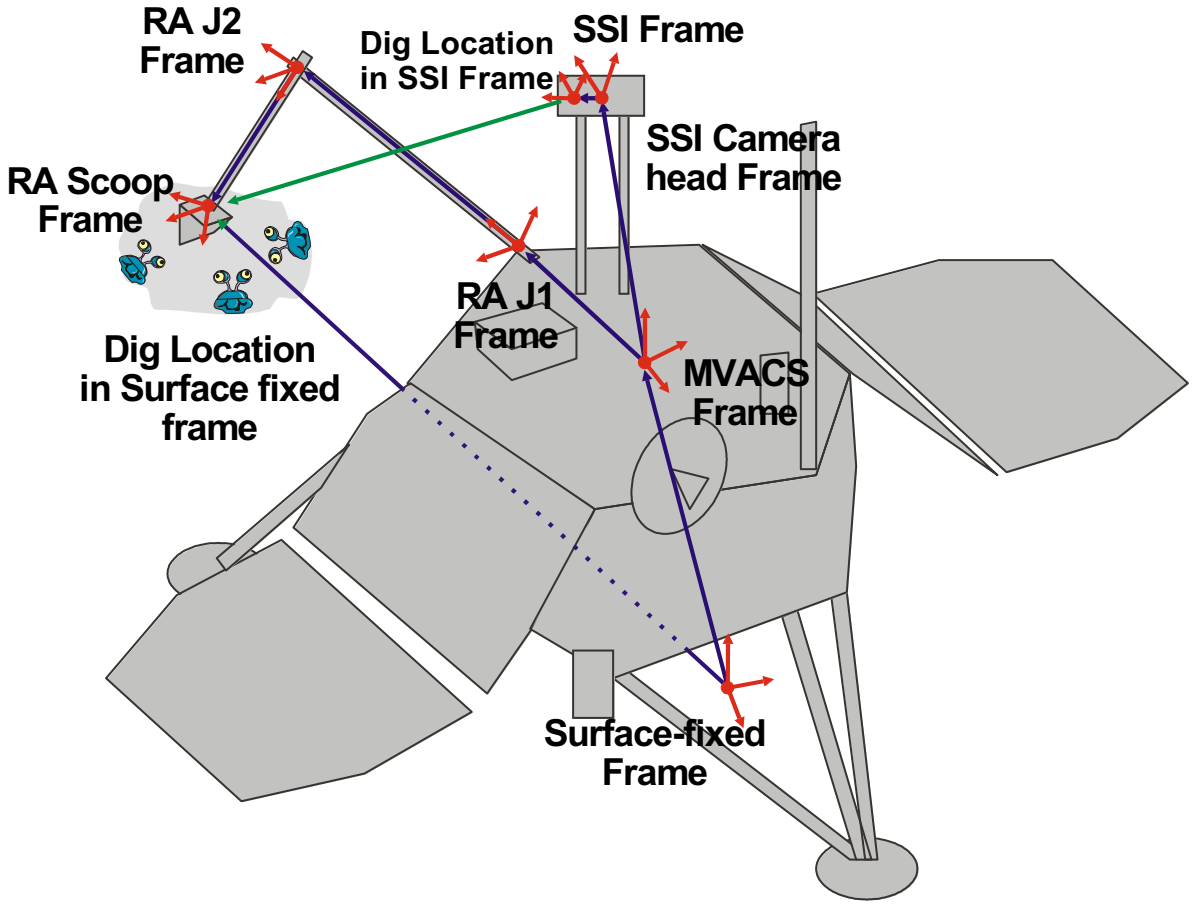
Compute the angle between the direction to Earth and the MGS HGA boresight:

```
CALL SPKEZR( 'EARTH', ET, 'MGS_HGA', 'LT+S', 'MGS', EARTH_STATE, LT )
ANGLE = VSEP( HGA_BORESIGHT, EARTH_STATE )
```

Fortran example

Manipulators - 2

Navigation and Ancillary Information Facility



Required Kernels:

- Generic LSK
- Mission FK
- Lander SCLK
- Structure Locations SPK
- Lander SPK
- Lander CK
- SSI CK
- RA CK

Compute the soil digging location in the MPL surface-fixed and camera left eye frames:

Fortran example

```
CALL SPKEZR( 'MPL_RA_SCOOP',ET,'MPL_SURFACE_FIXED','NONE','MPL_SURF',ST1,LT )
CALL SPKEZR( 'MPL_RA_SCOOP',ET,'MPL_SSI_LEFT',     'NONE','MPL_SSI', ST2,LT )
```